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Wisconsin's Timberland Plantations, 1983

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In 1983 the fourth Wisconsin forest inventory found 14.8 million timberland acres of which 622.3 thousand acres (4 percent) were classified as plantations. This bulletin presents analysis and statistics of area, volume, growth, and mortality.

KEY WORDS: Reforestation, area, volume, growth, mortality.

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FOREWORD

Information about Wisconsin's timberland plantations is based on data collected during the 1983 survey of the State's forest land. This survey was part of the federally mandated endeavor to periodically inventory the Nation's forest lands to determine the extent, condition, and volume of timber, growth, and removals. The 1983 Wisconsin survey was conducted by the Forest Inventory and Analysis (FIA) Unit at the USDA Forest Service North Central Forest Experiment Station in St. Paul, Minnesota. This unit, one of six FIA units nationwide, is responsible for inventories in 11 States.[1] Additional funds, provided by the Wisconsin Department of Natural Resources, permitted more intensive data collection than possible with a standard FIA survey, resulting in greater accuracy.

Results from the three previous surveys of Wisconsin were reported in 1938 (USDA Forest Service), 1961 (Stone and Thorne), and 1972 (Spencer and Thorne). Field work for the fourth inventory was begun in the summer of 1981 and completed in late 1983. Survey procedures and statewide results of the 1983 survey were published in 1988 (Spencer *et al.*). The most recent survey was the first to identify forest plantations in such a way as to permit separate analysis of their area, volume, and condition. This information will provide a base line for comparison with future surveys.

[1] *Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, South Dakota, and Wisconsin.*

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Wisconsin's Timberland Plantations, 1983

Sue M. Roussopoulos and Earl C. Leatherberry

Repeated logging and burning from the mid-1800's to the early decades of the 20th century devastated Wisconsin's once vast forests. Reforestation efforts, begun by the Civilian Conservation Corps, the Work Projects Administration, and county forest planting programs during the Depression and continued in the decades following World War II, have helped reestablish the State's forests. Conifer plantations have been instrumental in the amazing recovery that has taken place. Second growth timberlands now provide forest products, recreation, scenery, and wildlife for Wisconsin's citizens.

We define plantation here as an artificially reforested area sufficiently productive to qualify as timberland, *i.e.*, capable of producing growth in excess of 20 cubic feet per acre per year under management. Land managed for production of Christmas trees is classified as reserved forest land (see Appendix for Definition of terms) and is excluded from this report.

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Plantations were classified into forest types according to the intended dominant land use at the time of the inventory, *i.e.*, plantation, even though the planted species may not have been predominant on the site. Therefore, the forest type, stand age, and stand-size class for plantation plots always correspond to the planted trees, rather than to natural regeneration or overstory trees that may also be present on the plot. For example, a 30-year-old red pine plantation under a residual stand of scattered 150-year-old red oak would be classed as a 30-year-old red pine plantation.

FOUR FOREST TYPES PREDOMINATE

Bureau of the Census figures for 1980 put the total area of land and water in Wisconsin at 35.9 million acres. Of this area, FIA estimates classify 14.8 million acres as timberland. Plantations constitute an estimated 622.3 thousand acres (4 percent) of the State's timberland. Four softwood forest types account for 99 percent of plantation timberland. No hardwood plantations were encountered by FIA field crews. The remaining 1 percent of plantation timberland (5.5 thousand acres) is nonstocked. Red pine (*Pinus resinosa* Ait.) makes up 377.9 thousand acres or 61 percent of all plantation land. Red pine is a medium-sized tree with a well-formed, long, cylindrical bole. The wood, which is lightweight and close-grained, is used primarily for lumber and pulpwood. In the Lake States red pine is commonly found on level to gently rolling sand plains or low ridges adjacent to lakes and swamps. Its native range includes southern Canada, the Lake States, and the northeast U.S. Red pine is also one of the most extensively planted species in the northern U.S. and Canada (Rudolf 1990).

Land class	Area (Thousand acres)
Forest land	
Timberland	
Natural stands	14,137.1
Plantations	622.3
Woodland	331.0
Reserved timberland	260.9
Subtotal	15,351.3
Nonforest land	
Cropland	12,712.4
Pasture and range	2,128.7
Other	4,640.4
Subtotal	19,481.5
Water	1,105.0
Total land and water	35,937.8

Jack pine (*Pinus banksiana* Lamb.)[2] is the second most common plantation species in Wisconsin at 140.7 thousand acres (22 percent). It is a small- to medium-sized tree used for pulpwood, lumber, and roundwood (Rudolph and Laidly 1990). Jack pine is shade intolerant and occurs on poor sites characterized by dry, sandy, acid soils (Harlow *et al.* 1979). Jack pine is the most widely distributed pine in Canada, extending from Cape Breton in the east to the Mackenzie River in the Northwest Territories. In the U.S. it occurs primarily in Michigan, Minnesota, Wisconsin, and Maine.

Eastern white pine (*Pinus strobus* L.) accounts for an additional 55.0 thousand acres (9 percent) of plantations in Wisconsin. The even-grained wood of white pine is used for construction, millwork, trim, and pulpwood (Little 1978). White pine, which grows best on moist sandy loam soils, is the largest conifer in the eastern U.S. Before settlement, white pine formed extensive pure stands on sandy soils in the Lake States where trees 40 inches in diameter and 150 feet tall were not unusual (Merz 1978). Most of these virgin stands were cut by the turn of the century. The range of eastern white pine includes southern Canada, the Lake States, the Northeast U.S., and the Appalachian Mountains.

[2] *An estimated 2,200 acres of Scotch pine* (Pinus sylvestris *L.) have been included with the jack pine forest type.*

White spruce (*Picea glauca* (Moench) Voss)[3] makes up another 7 percent (43.2 thousand acres) of Wisconsin's plantation area. It is primarily a Canadian tree with a range that extends from Newfoundland to the Yukon and Alaska. However, it also extends into Michigan, Minnesota, Wisconsin, and northern New England. The wood of white spruce is light, straight grained, and used primarily for pulpwood and construction lumber (Nienstaedt and Zasada 1990). Across its range, this species may be found from sea level to 5 thousand feet in elevation and on soils that range from alkaline to acidic. In the Lake States, white spruce is typical of upland sites while black spruce is found on lowland sites (Merz 1978).

Statewide, nearly 80 percent of red pine and 66 percent of white spruce timberland has been artificially regenerated (fig. 1). Approximately 25 percent of both jack pine and white pine timberland area is in plantations.

[3] *Includes an estimated 2,700 acres of black spruce* (Picea mariana *(Mill.) B.S.P.) primarily planted on upland sites.*

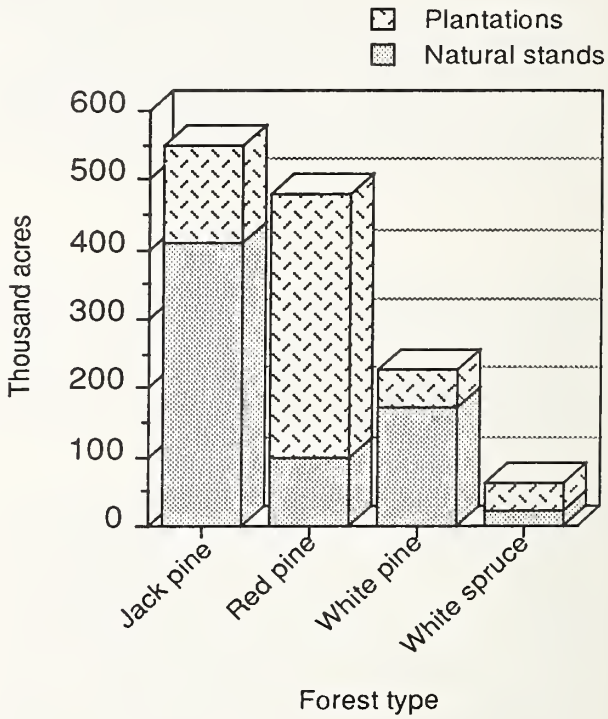

Figure 1.—*Distribution of natural stands and plantations within forest types, Wisconsin, 1983.*

The two northernmost Survey Units account for 57 percent of Wisconsin's plantation land (355.0 thousand acres) and 61 percent of all timberland in the State (fig. 2). The Central Survey Unit accounts for an additional 29 percent of plantation land (179.9 thousand acres) as well as 20 percent of the timberland area. The remaining 14 percent of plantation land (87.4 thousand acres) occurs in the two southern units, which also account for 19 percent of the State's timberland area.

Figure 2.—*Wisconsin Forest Survey Units.*

More than 52 percent (117.6 thousand acres) of Wisconsin's white pine timberland area is found in the northern two Survey Units, but only 9 percent is in plantations. In contrast, 41 percent of the 108.0 thousand acres of white pine in the rest of the State is planted. Fewer white pine plantations may have been established in the more productive northern Survey Units due to the risk of damage and mortality in young trees from white pine blister rust and white pine weevil (Wendel and Smith 1990).

POLETIMBER DOMINATES AREA

Poletimber is the dominant stand-size class in Wisconsin forest plantations; 42 percent of all plantation acres fall into this category (fig. 3). Of Wisconsin's timberland plantation area, 24 percent is in sawtimber stands, 33 percent is in sapling-seedling stands, and less than 1 percent is nonstocked.

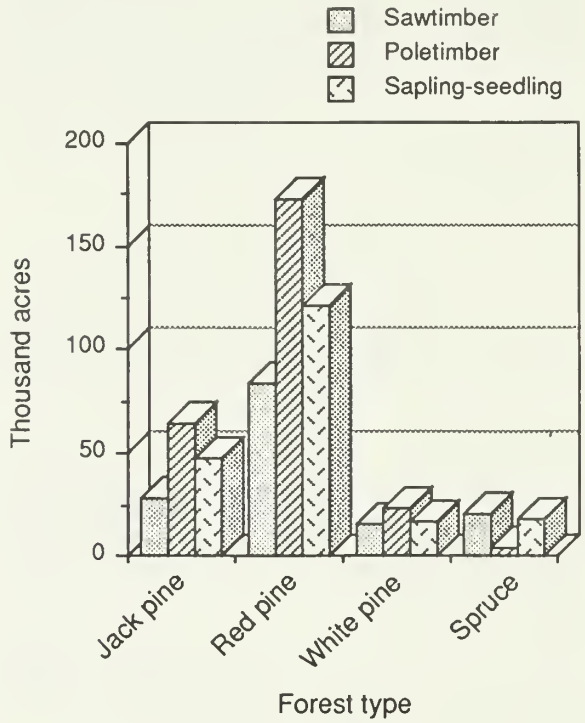

Figure 3.—*Plantation area by stand-size classes within forest types, Wisconsin, 1983.*

Spruce is a notable exception to this pattern. Only 9 percent of spruce plantation land is in poletimber stands. Sawtimber makes up 49 percent of spruce plantation acres, and the remainder (42 percent) is in the sapling-seedling class. Compared to other spruces, white spruce grows faster in early years and probably dies sooner (Harlow *et al.* 1979). This, coupled with an apparent lack of plantation white spruce in the 21- to 30-year age class, helps to explain the limited poletimber acreage.

PRODUCTIVITY HIGHER ON PLANTATIONS

For a given forest type, plantation sites are generally more productive than other timberland sites in Wisconsin. Given the substantial investment in plantation establishment, it is not surprising that sites with the potential to maximize return are more frequently chosen. Potential productivity is a means of classifying forest land in terms of its inherent capacity to grow crops of industrial wood. It is expressed as the expected growth (cubic feet per acre per year) at culmination of mean annual increment[4] in fully stocked, natural stands. Potential productivity reflects the maximum site potential, which is rarely achieved.

Less than 1 percent (4.4 thousand acres) of Wisconsin's plantation land is capable of producing more than 165 cubic feet per acre per year, while 43 percent (267.8 thousand acres) is estimated to produce less than 84 cubic feet per acre per year. These figures may appear discouraging, considering the expense of plantation establishment and management. Yet, a comparison of the proportion of plantation area and other timberland in each class shows a much higher proportion of plantations in the higher classes (fig. 4).

Only three percent of Wisconsin's timberland base has a potential site productivity equal to or greater than 120 cubic feet per acre per year, but 30 percent of this land is in plantations. Conversely, nearly 75 percent of the State's timberland is judged incapable of producing 85 or more cubic feet per acre per year. However, less than 3 percent of this land is in plantations.

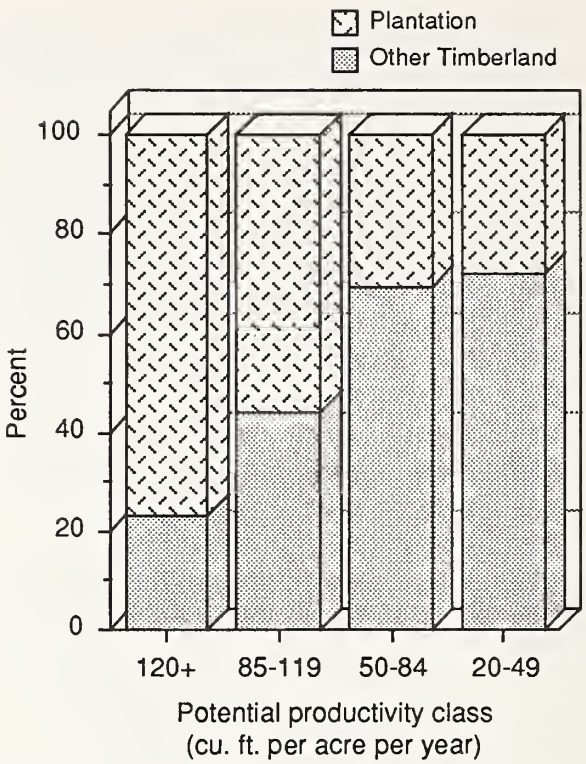

Figure 4.—*Distribution of plantation and other timberland area within potential productivity classes, for plantation forest types only, Wisconsin, 1983.*

The distribution of plantation acres across potential productivity classes is not uniform for plantation forest types (table 1). In general the area of red pine, white pine, and white spruce plantations increases with increasing productivity class. However, the area of jack pine plantations declines with increasing productivity class. FIA estimates indicate that 47 percent of jack pine plantations have been established in the lowest potential productivity class, exceeding the proportion of natural jack pine that occurs in the same class (41 percent).

Site index is another method used to describe site quality. It is defined as the height attainable by the average dominant and codominant trees of one species in a stand at an index age—50 years in this case. Site index reflects the combined effects of different environmental and edaphic factors, and is used as an indicator of stand productivity.

[4] *Culmination of mean annual increment is the point at which a curve plotting current annual increment crosses a curve plotting annual increment. Culmination of mean annual increment indicates the age at which average annual growth is the greatest, and thus, the rotation age of maximum volume-growth productivity.*

Table 1.—*Percent area by potential productivity class and forest type for plantation and other timberland, Wisconsin, 1983*

Forest type	Potential productivity class				
	120+	85-119	50-84	20-49	Total
			$ft^3/ac/yr$		
Jack pine					
Plantation	1.3	7.9	43.5	47.3	100.0
Other timberland	0.0	7.0	52.3	40.7	100.0
Red pine					
Plantation	30.8	44.6	20.2	4.4	100.0
Other timberland	18.0	46.4	31.4	4.2	100.0
White pine					
Plantation	34.5	25.5	21.3	18.7	100.0
Other timberland	12.8	43.8	32.2	11.2	100.0
White spruce					
Plantation	0.0	47.2	33.8	19.0	100.0
Other timberland	0.0	51.2	35.4	13.4	100.0

Nine percent of all plantation land is in site index classes between 30 and 50 feet; 78 percent is in classes between 50 and 80 feet; and 13 percent is in a site index class greater than 80 feet. No plantation plots were classed at site indexes below 30 feet. DeNaurois and Buongiorno (1986) found that at site index 45 or below red pine plantations are unlikely to be economical whether managed for saw logs, pulpwood, or both. However, this does not appear to be a serious problem in Wisconsin because only 3 percent (12.0 thousand acres) of red pine plantations are on land classed below 50 feet.

ESTABLISHMENT RATE DECLINES DRAMATICALLY

The decade from 1963 to 1972 marked the peak period of planting in Wisconsin (fig. 5). Nearly 153 thousand acres (25 percent of all plantation land) were planted in that decade. FIA estimates indicate only half as many acres were planted between 1973 and 1982, the decade immediately preceding the inventory. That marked the first decadal decline in acres planted as well as the smallest plantation area established since the 1923 to 1932 period.

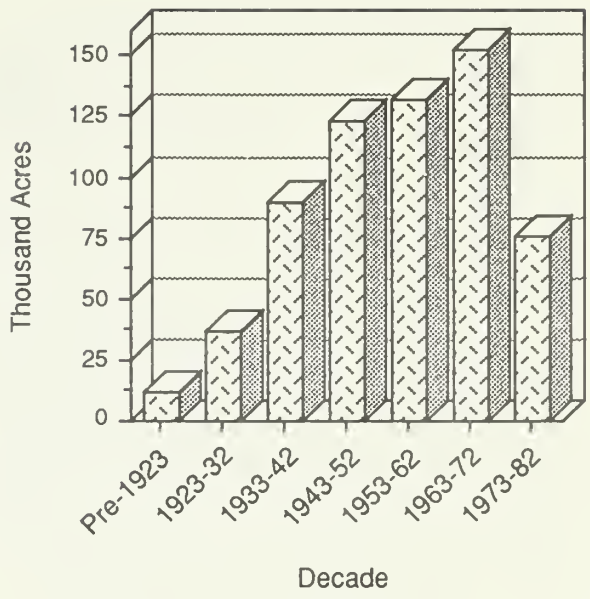

Figure 5.—*Area planted by decade, Wisconsin, 1983.*

Fifty-eight percent of plantations were less than 30 years old; 92 percent were less than 50 years old. As expected, natural stands in Wisconsin are generally older. Only 29 percent of non-plantation timberland is stocked with trees less than 30 years old; 54 percent with trees less than 50 years old.

Fifty-eight percent of the plantation area established before 1933 was planted to jack pine. Jack pine may have been favored for these early reforestation efforts because it has better survival and early growth rates than red and white pine, which are longer lived and produce higher quality, larger products. Since 1933 more red pine has been planted in each 10-year period than all other species combined. From 1953 to 1962, the largest area ever (103.9 thousand acres) was planted to red pine and there was a marked shift away from planting other species. Ninety-five percent of all red pine timberland less than 30 years old is found in plantations.

Only 5 percent (2.0 thousand acres) of all spruce plantation area was established during the 1953 to 1962 period, which corresponds to the current 21- to 30-year age class. This helps to explain the lack of poletimber in spruce plantations.

HALF OF PLANTATION AREA UNDISTURBED

FIA field crews found 52 percent (322.2 thousand acres) of plantation land undisturbed by natural or human causes within the last 20 years. The types of disturbance noted by field crews include harvest and planting; damage from fire, wind, disease, and insects; and human-caused damage such as altered drainage, chemical spraying, and salt damage. Timber harvest was a common cause of disturbance on plantations. Clearcutting was done on 16.9 thousand acres, while some form of partial harvest was carried out on an additional 84.6 thousand acres. Less than 1 percent of plantation acres were damaged by natural or human causes.

STANDS CAN BENEFIT FROM THINNING

Timber stand improvement measures, such as thinning or pruning, were done on less than 3 percent of all plantation land. More than half of the stand improvement activities were in the red pine forest type. Nearly 30 percent (174.9 thousand acres) of all plantation land is currently stocked at more than 120 square feet of basal area per acre. These stands may benefit from thinning, which increases merchantable yields, reduces rotation age, and enhances rate of return on investments. For example, red pine management guidelines (Benzie 1977) indicate that red pine plantation land with basal area greater than 140 square feet per acre, of which there are 87.3 thousand acres in Wisconsin, needs to be thinned. Plantations may go unthinned for many reasons including: expense of thinning operations, lack of markets for thinning products, change in land ownership, and change in land management objectives.

PLANTATIONS CLOSELY TIED TO ROADS

Ninety-seven percent of all timberland, plantation or otherwise, in Wisconsin is within 1 mile of a maintained road. Plantation land is even more closely tied to the road network than other timberland. This is to be expected, given the cost of planting, stand improvement, and eventual harvest. Seventy percent of plantation land is less than one-quarter mile from a maintained road, compared to 49 percent of other timberland. Ninety-nine percent of plantation land is within 1 mile of a maintained road.

PRIVATE AND PUBLIC SECTORS SPLIT OWNERSHIP

Ownership of plantation timberland is evenly distributed between the public (49 percent) and private (51 percent) sectors. Twenty-four percent (148.5 thousand acres) of plantation land is in Federal ownership (fig. 6). Eighty-three percent of these acres are in the Nicolet and Chequamegon National Forests. County and local governments account for another 20 percent (123.1 thousand acres) and the State owns 5 percent (32.4 thousand acres).

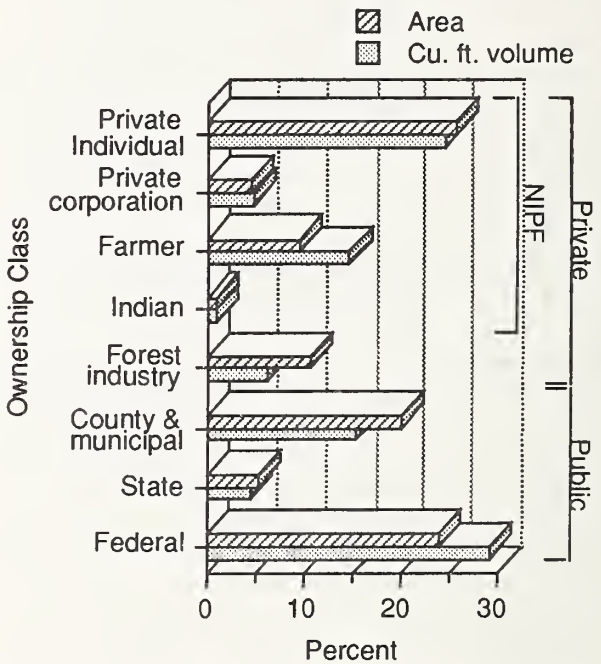

Figure 6.—*Distribution of plantation area and growing-stock volume across ownership groups, Wisconsin, 1983.*

Fifty percent (158.5 thousand acres) of the plantation land in private ownership is held by individuals—not including farmers, who own an additional 19 percent (59.8 thousand acres). Forest industry accounts for 21 percent of privately owned plantation land, corresponding to 11 percent of all plantation acres. Less than 1 percent of plantation acres are on land held by Native American tribal groups or individuals.

Ten percent of the timberland in Federal ownership is in plantations, the highest proportion of all ownership classes. Less than 6 percent of timberland held by county and local governments is in plantations. Nonindustrial private forest (NIPF) land owners hold 40 percent of the State's plantation acres, but these acres represent less than 3 percent of NIPF-owned land. Future timber production is not of primary importance to many NIPF owners. Of 875 Wisconsin NIPF landowners surveyed, 30 percent of respondents indicated timber production was important while 49 percent said it was unimportant (Roberts *et al.* 1986). Seventy-four and sixty-nine percent cited wildlife habitat and scenic enjoyment, respectively, as an important reason for owning woodlands. In a similar landowner study conducted in Michigan's Upper Peninsula, 45 percent of 271 NIPF landowners surveyed cited recreation as their primary reason for owning forest land (Carpenter 1985).

Red pine appears to be the preferred plantation species for all ownership classes. As owner groups, the public sector, forest industry, and NIPF owners, respectively, have 59, 61, and 63 percent of their plantation land in red pine. Nearly 80 percent (21.8 thousand acres) of plantation land owned by private corporations is planted to red pine. This preference for red pine reflects the type's wide site adaptability, high productivity, and low susceptibility to insects and disease. Sixty percent (26.0 thousand acres) of white spruce plantations are in public ownership with the vast majority occurring on national forests. Seventy percent of white pine plantation land is NIPF-owned.

LAND OWNERSHIP STABLE

Information on the length of time a property has been held by the owner is collected for privately owned land. Forty-four percent (138.6 thousand acres) of private land currently in plantations has been held by the same owner for more than 20 years. This, along with the 304.0 thousand acres in public ownership, indicates a fairly stable base for Wisconsin's plantation lands. Eighty-two percent (54.5 thousand acres) of industry-owned plantation land has been held for more than 20 years. Eighty-three percent (43.7 thousand acres) of privately owned plantation land held for less than 5 years is owned by private individuals.

FIVE PERCENT OF GROWING-STOCK VOLUME IN PLANTATIONS

Wisconsin's 622.3 thousand acres of plantation land support 714.3 million cubic feet of growing-stock volume amounting to 5 percent of the State's total growing-stock volume. Average growing-stock volume per acre on plantation land in stands 60 years of age and younger is 1,140 cubic feet, compared to 874 cubic feet for stands on other timberland in the same age classes.

Sawtimber volume on plantation land totaled 1.3 billion board feet[5] in 1983. Plantation sawtimber volume represents 4 percent of the State total. The average sawtimber volume per acre on plantation land in stands 60 years of age or younger is 2,083 board feet compared to 1,386 board feet for stands on other timberland in the same age classes.

[5] *International 1/4-inch rule.*

RED PINE DOMINATES GROWING-STOCK VOLUME

The red pine forest type comprises nearly two-thirds of the State's plantation growing-stock volume (fig. 7). The forest type assigned to plantation land always corresponds to the species planted. However, other species are frequently present. For example, in both red and jack pine plantations, approximately 14 percent of growing-stock volume is in other species groups. In spruce plantations less than 10 percent of volume is in other species. Fifteen percent of the volume in white pine plantations is in red pine with an additional 18 percent in hardwoods, primarily cottonwood, quaking aspen, oak, soft maple, and paper birch. The large component of red pine found in white pine plantations may be due to mixed planting. Red pine was planted along with white pine in an attempt to reduce damage from white pine weevil, a primary enemy of white pine that rarely attacks red pine (Rudolf 1950). The presence of significant hardwood volume in white pine plantations suggests that hardwoods were either present before, or came in after, planting.

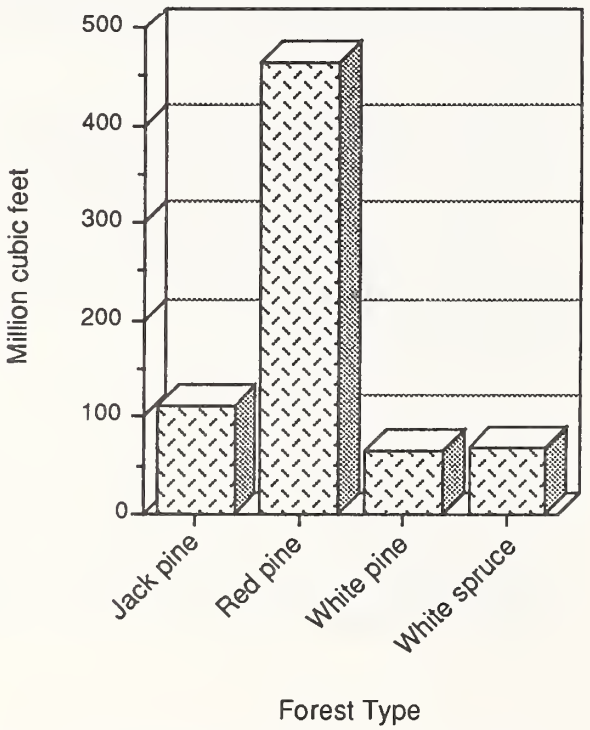

Figure 7.—*Plantation growing-stock volume by forest type, Wisconsin, 1983.*

OVER HALF OF VOLUME IN POLETIMBER

Sixty-one percent (435.4 million cubic feet) of plantation growing-stock volume is in poletimber-size trees. Seventy-eight percent of sawtimber volume is in trees 9 to 13 inches in diameter at breast height (d.b.h.) with the remaining 22 percent in trees larger than 13 inches d.b.h. White pine is a notable exception to this pattern. Sixty-two percent of white pine sawtimber volume is in trees with d.b.h. greater than 13 inches.

MOST VOLUME IN 21- TO 50-YEAR-OLD STANDS

The bulk of plantation growing-stock volume (637.1 million cubic feet or 89 percent of total volume) is in stands that were under 50 years of age in 1983 (fig. 8). Stands aged 21 to 50 years contain close to 79 percent of all plantation growing-stock volume. The decade from 1963 to 1972 marked the peak period of planting (fig. 5). At the time of the survey, trees in those plantings were between 11 and 20 years old and too small to contribute much to growing-stock volume.

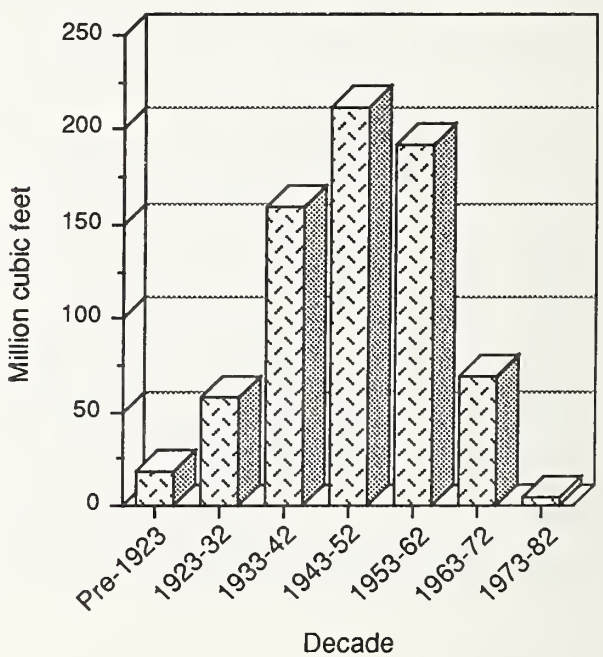

Figure 8.—*Plantation growing-stock volume by decade planted, Wisconsin, 1983.*

More red pine growing-stock volume is concentrated in younger age classes than other plantation forest types. Sixty-seven percent (309.6 million cubic feet) of red pine growing-stock volume is in 21- to 40-year-old stands. Eighty percent (90.2 million cubic feet) of jack pine volume is in stands between 31 and 60 years old. In white spruce plantations, 93 percent (64.4 million cubic feet) of volume is in 31- to 60-year-old stands.

Plantation stands over 20 years of age with high stand density typically grow slowly. Forty-three percent (198.6 million cubic feet) of red pine growing-stock volume is in stands over 20 years of age that have basal areas greater than 140 square feet per acre. Red pine management guidelines indicate these stands may benefit substantially from thinning (Benzie 1977). Without thinning, most of these stands will be less productive.

NET ANNUAL GROWTH HIGHER ON PLANTATION LANDS

The net annual growth of growing stock on plantation land is 45.9 million cubic feet. The 1982 growth rate for plantation timberland was 6 percent of inventory compared to a rate of 3 percent on other timberland statewide. Growth rates for individual species ranged from 4 percent for spruce to 8 percent for red pine. The northern two Survey Units account for 55 percent (394.5 million cubic feet) of the State's plantation growing-stock volume and represent 48 percent (22.0 million cubic feet) of net annual growth of growing stock.

Average net annual growth per acre of growing stock on plantation land is 73.7 cubic feet, far above the 31.5 cubic feet for other timberland statewide. Average net annual growth per acre for individual species ranges from 86.1 cubic feet for red pine to 35.2 cubic feet for jack pine. The average net annual growth per acre is 62 cubic feet in the northern two Survey Units. In the remainder of the State—roughly the southern two-thirds—the average net annual growth per acre is 89 cubic feet.

Net annual growth of plantation sawtimber is 116.5 million board feet. Average net annual growth of plantation sawtimber is 187.3 board feet per acre compared to 93.8 board feet for other timberland. Average net annual growth of sawtimber for individual species ranged from 277.5 board feet per acre for spruce to 115.8 for jack pine.

GROWING-STOCK MORTALITY LOW

Plantation growing-stock mortality amounted to 2.0 million cubic feet in 1982, or 0.3 percent of inventory. The average growing-stock mortality on plantation land was 3.1 cubic feet per acre compared to 9.5 for other timberland acres. Forty-two percent (812,000 cubic feet) of plantation volume lost to mortality was in species groups other than the plantation species, primarily aspen, oak, and elm.

The primary cause of death could not be clearly identified for three-quarters of plantation growing-stock mortality volume. Of the 448,000 cubic feet of mortality for which a primary cause was assigned, disease accounted for the largest proportion (44 percent), followed by suppression (26 percent), fire (12 percent), and weather (11 percent). Causes of mortality varied with species group. For instance, where the causal factor was identified, 82 percent of white pine mortality was attributed to insects and 95 percent of spruce mortality was attributed to suppression.

VOLUME SPLIT BETWEEN PRIVATE AND PUBLIC SECTORS

As with plantation area, growing-stock volume is evenly divided between public (49 percent or 350.9 million cubic feet) and private (51 percent or 363.3 million cubic feet) ownership (fig. 6). Fifty-five percent (192.0 million cubic feet) of publicly owned growing-stock volume is on national forest land. County and municipal governments account for 32 percent (111.2 million cubic feet) of publicly owned land; the State owns 9 percent (32.4 million cubic feet).

Private individuals own 55 percent (174.5 million cubic feet) of NIPF growing-stock volume. Farmers own 33 percent (105.0 million cubic feet) of plantation volume, and private corporations own 11 percent (34.5 million cubic feet). The remaining 1 percent of NIPF-owned volume (5.2 million cubic feet) is owned by Indian tribal groups or individuals.

LOOKING AHEAD

Forest plantations have been instrumental in restocking cut over and burned timberland in Wisconsin. In each decade from 1923 to 1972 the area of plantations established in Wisconsin increased. However, FIA estimates indicate that from 1972 to 1982 planting activities declined dramatically; only half as many acres were planted as in the previous decade (fig. 5).

What should we expect for future timberland plantations in Wisconsin? Several social and economic factors interplay to influence landowners' decisions to plant or not. For example, recent Federal and State incentives may influence future planting activities. Under Wisconsin forest tax laws, landowners are provided specific tax relief for managing their forest lands, including planting and harvesting. Recently enacted Federal programs, principally the Conservation Reserve Program and the Stewardship Incentive Program, provide landowners with financial assistance for tree planting.

Although conifer plantations will continue to be important, there is increasing interest in the regeneration of hardwoods. This is especially true of oaks, which are in great demand in the Upper Midwest and are often difficult to regenerate naturally after harvest. The impact of these and other factors on plantation establishment may not be fully appreciated until the next FIA survey of Wisconsin. As future surveys are conducted, the information presented here, as well as additional, unpublished data maintained by the St. Paul FIA Unit, will provide a valuable baseline for comparing past plantation practices with developing trends across the State.

LITERATURE CITED

Benzie, J.W. 1977. **Manager's handbook for red pine in the north central States**. Gen. Tech. Rep. NC-33. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 22 p.

Carpenter, E.M. 1985. **Ownership change and timber supply on nonindustrial private forest land**. Res. Pap. NC-265. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 14 p.

DeNaurois, M.; Buongiorno, J. 1986. **Economics of red pine plantation management in Wisconsin**. Northern Journal of Applied Forestry. 3: 118-123.

Harlow, W.M.; Harrar, E.S.; White, F.M. 1979. **Textbook of dendrology**. 6th ed. New York, NY: McGraw-Hill. 510 p.

Little, Elbert L., Jr. 1978. **Important forest trees of the United States**. Agric. Handb. 519. Washington, DC: U.S. Department of Agriculture, Forest Service. 70 p.

Merz, Robert W. 1978. **Forest atlas of the Midwest**. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station; Upper Darby, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; St. Paul, MN: University of Minnesota, College of Forestry. 48 p.

Nienstaedt, Hans; Zasada, John C. 1990. ***Picea glauca* (Moench) Voss.: White Spruce**. In: Burns, Russell M.; Honkala, Barbara H., tech. coords. Silvics of North America: vol. 1. Conifers. Agric. Handb. 654. Washington, DC: U.S. Department of Agriculture, Forest Service: 204-226.

Roberts, J.C.; Tlusty, W.G.; Jordahl, H.C., Jr. 1986. **The Wisconsin private non-industrial woodland owner: a profile**. Occas. Pap. Ser. 19. Madison, WI: University of Wisconsin Cooperative Extension Service. 127 p.

Rudolf, Paul O. 1990. ***Pinus resinosa* Ait.: Red Pine**. In: Burns, Russell M.; Honkala, Barbara H., tech. coords. Silvics of North America: vol. 1. Conifers. Agric. Handb. 654. Washington, DC: U.S. Department of Agriculture, Forest Service: 442-455.

Rudolph, T.D.; Laidly, P.R. 1990. ***Pinus banksiana* Lamb.: Jack Pine**. In: Burns, Russell M.; Honkala, Barbara H., tech. coords. Silvics of North America: vol. 1. Conifers. Agric. Handb. 654. Washington, DC: U.S. Department of Agriculture, Forest Service: 280-293.

Spencer, J.S., Jr.; Thorne, H.W. 1972. **Wisconsin's 1968 timber resource**. Resour. Bull. NC-15. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 80 p.

Spencer, J.S., Jr.; Smith, W.B.; Hahn, J.R.; Raile, G.K. 1988. **Wisconsin's fourth forest inventory, 1983**. Resour. Bull. NC-107. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 158 p.

Stone, R.N.; Thorne, H.W. 1961. **Wisconsin's forest resource**. Stn. Pap. 90. St. Paul, MN: U.S. Department of Agriculture, Forest Service, Lake States Forest Experiment Station. 52 p.

U.S. Department of Agriculture, Forest Service. 1938. **Forest areas and timber volume in the Lake States**. Econ. Notes 10. St. Paul, MN: U.S. Department of Agriculture, Forest Service, Lake States Forest Experiment Station. 84 p.

Wendel, G.W.; Smith, H. Clay. 1990. ***Pinus strobus* L.: Eastern White Pine**. In: Burns, Russell M.; Honkala, Barbara H., tech. coords. Silvics of North America: vol. 1. Conifers. Agric. Handb. 654. Washington, DC: U.S. Department of Agriculture, Forest Service: 476-488.

APPENDIX

DEFINITION OF TERMS

Basal area.—Square feet of the cross section at breast height of a single tree. When the basal areas of all live trees in a stand are summed, the result is usually expressed as square feet of basal area per acre.

County and municipal land.—Land owned by counties and local public agencies or municipalities, or land leased to these governmental units for 50 years or more.

Cropland.—Land under cultivation within the past 24 months; including cropland harvested, crop failures, cultivated summer fallow, idle cropland used only for pasture, orchards, and land in soil improvement crops, but excluding land cultivated in developing improved pasture.

Diameter class.—A classification of trees based on diameter outside bark, measured at breast height (4.5 feet above the ground). (Note: D.b.h. is the common abbreviation for diameter at breast height. Two-inch classes are commonly used in Forest Inventory and Analysis, with the even inch the approximate midpoint for a class. For example, the 6-inch class includes trees 5.0 through 6.9 inches d.b.h. inclusive.

Farmer-owned land.—Land owned by farm operators. (Note: Excludes land leased by farm operators from nonfarm owners, such as railroad companies and States.)

Forest industry land.—Land owned by companies or individuals operating primary wood-using plants.

Forest land.—Land at least 16.7 percent stocked by forest trees of any size, or formerly having had such tree cover, and not currently developed for nonforest use.

Forest type.—A classification of forest land based upon the species forming a plurality of live tree stocking. Forest types represented in Wisconsin plantations are jack pine, red pine, white pine, white spruce, black spruce, and exotic (Scotch pine).

Growing-stock trees.—Live trees of commercial species meeting the size and quality standards that satisfy merchantability requirements.

Indian land.—All lands held in trust by the United States for individual Native Americans or tribes.

Maintained road.—Any road, hard-topped or other surface, that is plowed or graded at least once a year. Includes rights-of-way that are cut or treated to limit herbaceous growth.

Miscellaneous federal land.—Federal land other than national forest.

Miscellaneous private land.—Privately owned land other than forest-industry and farmer-owned land.

National forest land.—Federal lands that have been legally designated as national forest or purchase units, and other land under the administration of the USDA Forest Service.

Nonforest land.—Land that has never supported forests, and land formerly forested where use for timber management is precluded by development for other uses.

Nonindustrial private forest land.—Privately owned forest land including farmer-owned and Native American land, but excluding forest industry land.

Nonstocked land.—Timberland less than 16.7 percent stocked with growing-stock trees.

Ownership.—Property owned by one owner, regardless of the number of parcels in a specified area.

Ownership size class.—A classification of forest land in terms of the amount of timberland owned by one owner, regardless of the number of parcels.

Owner tenure.—The length of time a property has been held by the owner.

Pasture and range.—Land that is currently improved for grazing by cultivation, seeding, or irrigation plus land on which the natural plant cover is composed principally of native grasses, forbs, or shrubs valuable for forage.

Plantation.—An artificially reforested area sufficiently productive to qualify as timberland. The planted species is not necessarily predominant.

Poletimber stands.—(See definition of Stand-size class.)

Poletimber trees.—Growing-stock trees of commercial species at least 5 inches d.b.h., but smaller than sawtimber size.

Potential productivity class.—A classification of forest land in terms of inherent capacity to grow crops of industrial wood based on the culmination of mean annual increment for fully stocked natural stands. Potential productivity class values are presented in cubic feet of growth per acre per year that might be expected if the above conditions are met.

Reserved forest land.—Forest land withdrawn from timber utilization through statute, administrative regulation, designation, or exclusive use for Christmas tree production, as indicated by annual shearing.

Saplings.—Live trees 1 to 5 inches d.b.h.

Sapling-seedling stands.—(see definition of Stand-size class.)

Saw log.—A log meeting minimum standards of diameter, length, and defect, including logs at least 8 feet long, sound and straight and with a minimum diameter outside bark for softwoods of 7 inches (9 inches for hardwoods) or other combinations of size and defect specified by regional standards.)

Sawtimber stands.—(See definition of Stand-size class.)

Sawtimber trees.—Growing-stock trees of commercial species containing at least a 12-foot saw log or two noncontiguous saw logs 8 feet or longer, and meeting regional specifications for freedom from defect. Softwoods must be at least 9 inches d.b.h. Hardwoods must be at least 11 inches d.b.h.

Seedlings.—Live trees less than 1 inch d.b.h. that are expected to survive. Only softwood seedlings more than 6 inches tall and hardwood seedlings more than 1 foot tall are counted.

Site index.—An expression of forest site quality based on the height of a free-growing dominant or codominant tree of a representative species in the forest type at age 50.

Stand.—A group of trees on a minimum of 1 acre of forest land that is stocked by forest trees of any size.

Stand-age class.—Age of the main stand or of the planted trees in the case of plantations.

Stand-size class.—A classification of forest land based on the size class of growing-stock trees on the area; that is, sawtimber, poletimber, or seedlings and saplings.

Sawtimber stands.—Stands at least 16.7 percent stocked with growing-stock trees, with at least half of total stocking in sawtimber or poletimber trees, and with sawtimber stocking at least equal to poletimber stocking.

Poletimber stands.—Stands at least 16.7 percent stocked with growing-stock trees of which at least half of this stocking is in poletimber and/or sawtimber trees, and with poletimber stocking exceeding that of sawtimber.

Sapling-seedling stands.—Stands at least 16.7 percent stocked with growing-stock trees of which more than half of the stocking is saplings and/or seedlings.

Nonstocked stands.—Stands in which stocking of growing-stock trees is less than 16.7 percent.

State land.—Land owned by States, or land leased to these governmental units for 50 years or more.

Stocking.—The degree of occupancy of land by trees, measured by basal area and/or the number of trees in a stand by size or age and spacing, compared to the basal area and/or number of trees required to fully utilize the growth potential of the land; that is the stocking standard.

A stocking percent of 100 indicates full utilization of the site and is equivalent to 80 square feet of basal area per acre in trees 5 inches d.b.h. and larger. In a stand of trees less than 5 inches d.b.h., a stocking percent of 100 would indicate that the present number of trees is sufficient to produce 80 square feet of basal area per acre when the trees reach 5 inches d.b.h.

Stands are grouped into the following stocking classes:

Overstocked stands.—Stands in which stocking of trees is 130.0 percent or more.

Fully stocked stands.—Stands in which stocking of trees is from 100.0 to 129.9 percent.

Moderately stocked stands.—Stands in which stocking of trees is from 60.0 to 99.0 percent.

Poorly stocked stands.—Stands in which stocking of trees is from 16.7 to 59.9 percent.

Nonstocked stands.—Timberland on which stocking of trees is less than 16.7 percent.

Timberland.—Forest land producing or capable of producing crops of industrial wood and not withdrawn from timber utilization. (Note: Areas qualifying as timberland have the capability of producing in excess of 20 cubic feet per acre per year of annual growth under management. Currently inaccessible and inoperable areas are included, except when the areas involved are small and unlikely to become suitable for production of industrial wood in the foreseeable future.)

Woodland.—Forest land incapable of producing 20 cubic feet per acre of annual growth or of yielding crops of industrial wood under natural conditions because of adverse site conditions. (Note: Adverse conditions include shallow soils, dry climate, poor drainage, high elevation, steepness, and rockiness.)

TABLE TITLES

Area

Table 2.—Area of timberland plantations by forest type and Forest Survey Unit, Wisconsin, 1983

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Growth

Table 15.—Net annual growth of growing stock and sawtimber on timberland plantations by species group and forest type, Wisconsin, 1982

Mortality

Table 16.—Net annual mortality of growing stock and sawtimber on timberland plantations by species group and cause of mortality, Wisconsin, 1983

Table 2.--Area of timberland plantations by forest type and Forest Survey Unit, Wisconsin, 1983

(In thousand acres)

Forest type	All Units	Forest Survey Unit				
		Northeast	Northwest	Central	Southwest	Southeast
Jack pine	140.7	22.4	72.5	38.0	5.1	2.7
Red pine	377.9	118.1	97.9	114.9	34.8	12.2
White pine	55.0	5.4	5.1	22.5	10.3	11.7
Spruce	43.2	16.2	17.4	2.2	2.5	4.9
Nonstocked	5.5	--	--	2.3	3.2	--
All types	622.3	162.1	192.9	179.9	55.9	31.5

Table 3.--Area of timberland plantations by forest type and stand-size class, Wisconsin, 1983

(In thousand acres)

Stand-size class	All types	Forest type				
		Jack pine	Red pine	White pine	Spruce	Nonstocked
Sawtimber	148.3	28.6	83.8	14.9	21.0	--
Poletimber	264.9	64.0	173.4	23.4	4.1	--
Seedling & sapling	203.6	48.1	120.7	16.7	18.1	--
Nonstocked	5.5	--	--	--	--	5.5
All classes	622.3	140.7	377.9	55.0	43.2	5.5

Table 4.--Area of timberland plantations by forest type and potential productivity class, Wisconsin, 1983

(In thousand acres)

Forest type	All classes	Potential productivity class (cubic feet of growth per acre per year)			
		120+	85-119	50-84	20-49
Jack pine	140.7	1.9	11.1	61.2	66.5
Red pine	377.9	116.2	168.7	76.5	16.5
White pine	55.0	19.0	14.0	11.7	10.3
Spruce	43.2	--	20.4	14.6	8.2
Nonstocked	5.5	--	3.2	--	2.3
All types	622.3	137.1	217.4	164.0	103.8

Table 5.--Area of timberland plantations by forest type and stand-age class, Wisconsin, 1983

(In thousand acres)

Forest type	All classes	Stand-age class (years)						
		1-10	11-20	21-30	31-40	41-50	51-60	61+
Jack pine	140.7	5.7	28.5	20.1	33.4	24.6	22.0	6.4
Red pine	377.9	52.2	96.7	103.9	71.4	47.5	4.2	2.0
White pine	55.0	7.6	13.9	5.9	6.3	13.4	3.9	4.0
Spruce	43.2	4.3	13.7	2.0	12.2	4.4	6.6	--
Nonstocked	5.5	5.5	--	--	--	--	--	--
All types	622.3	75.3	152.8	131.9	123.3	89.9	36.7	12.4

Table 6.--Area of timberland plantations by forest type and distance to road, Wisconsin, 1983

(In thousand acres)

Forest type	All classes	Distance to road (miles)			
		0-.125	.125-.25	.25-1.0	1.0+
Jack pine	140.7	47.2	30.9	62.6	--
Red pine	377.9	165.0	118.4	86.6	7.9
White pine	55.0	23.2	18.0	13.8	--
Spruce	43.2	12.0	16.7	14.5	--
Nonstocked	5.5	--	5.5	--	--
All types	622.3	247.4	189.5	177.5	7.9

Table 7.--Area of timberland plantations by forest type and basal area class, Wisconsin, 1983

(In thousand acres)

Forest type	All classes	Basal area class (square feet per acre)				
		<40	41-80	81-100	101-140	141+
Jack pine	140.7	16.9	47.4	40.6	28.5	7.3
Red pine	377.9	83.6	47.8	44.2	115.0	87.3
White pine	55.0	10.5	11.9	6.4	15.4	10.8
Spruce	43.2	6.0	14.8	4.1	--	18.3
Nonstocked	5.5	5.5	--	--	--	--
All types	622.3	122.5	121.9	95.3	158.9	123.7

Table 8.--Area of timberland plantations by ownership class and forest type, Wisconsin, 1983

(In thousand acres)

Ownership class	All types	Forest type				
		Jack pine	Red pine	White pine	Spruce	Nonstocked
National forest	122.8	11.6	87.0	1.7	22.5	--
Misc. federal	25.7	4.3	9.0	6.9	--	5.5
State	32.4	9.9	16.8	4.0	1.7	--
County and municipal	123.1	51.2	66.2	3.9	1.8	--
Indian	5.7	2.2	3.5	--	--	--
Forest industry	66.7	23.9	40.8	--	2.0	--
Farmer	59.8	12.1	28.6	16.4	2.7	--
Misc. private corporation	27.6	2.2	21.8	3.6	--	--
Misc. private individual	158.5	23.3	104.2	18.5	12.5	--
All owners	622.3	140.7	377.9	55.0	43.2	5.5

Table 9.--Area of timberland plantations by forest type and site-index class, Wisconsin, 1983

(In thousand acres)

Forest type	All classes	Site-index class (feet)						
		<40	41-50	51-60	61-70	71-80	81-90	91+
Jack pine	140.7	4.3	20.0	53.6	42.0	17.2	1.7	1.9
Red pine	377.9	6.4	5.6	47.4	134.0	122.5	57.6	4.4
White pine	55.0	4.1	3.9	11.8	9.2	11.3	12.1	2.6
Spruce	43.2	--	12.6	6.6	2.0	22.0	--	--
Nonstocked	5.5	--	2.3	--	3.2	--	--	--
All types	622.3	14.8	44.4	119.4	190.4	173.0	71.4	8.9

Table 10.--Net volume of growing stock and sawtimber on timberland plantations by species group and forest type, Wisconsin, 1983

Species group	All types	Forest type			
		Jack pine	Red pine	White pine	Spruce
		Growing stock			
		Thousand cubic feet			
Jack pine	110,841	97,528	11,340	1,973	--
Red pine	414,006	5,977	397,923	9,751	355
White pine	65,761	3,489	20,413	41,859	--
Spruce	64,723	--	1,830	--	62,893
Other softwoods	3,644	902	1,653	770	319
Hardwoods	55,303	5,480	32,041	12,309	5,473
All species	714,278	113,376	465,200	66,662	69,040
		Sawtimber			
		Thousand board feet[1]			
Jack pine	204,218	180,962	18,377	4,879	--
Red pine	665,520	21,675	617,262	26,583	--
White pine	202,787	14,865	68,447	119,475	--
Spruce	174,561	--	1,902	--	172,659
Other softwoods	7,276	1,530	2,653	1,357	1,736
Hardwoods	86,832	6,954	49,579	22,997	7,302
All species	1,341,194	225,986	758,220	175,291	181,697

[1]International 1/4-inch rule.

Table 11.--Net volume of growing stock and sawtimber on timberland plantations by species group and diameter class, Wisconsin, 1983

Species group	All classes	Diameter class (inches at breast height)							
		5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0+
					Growing stock				
					Thousand cubic feet				
Jack pine	110,841	33,130	35,408	27,109	11,780	2,592	822	--	--
Red pine	414,006	139,086	144,719	74,985	40,607	7,018	4,956	2,473	162
White pine	65,761	12,508	11,962	8,323	8,416	8,147	7,633	6,627	2,145
Spruce	64,723	8,844	21,586	18,377	12,948	2,968	--	--	--
Other softwoods	3,644	1,244	944	676	610	--	--	--	170
Hardwoods	55,303	15,060	10,935	8,924	8,479	8,731	600	1,110	1,464
All species	714,278	209,872	225,554	138,394	82,840	29,456	14,011	10,210	3,941
					Sawtimber				
					Thousand board feet[1]				
Jack pine	204,218	--	--	128,743	57,730	13,385	4,360	--	--
Red pine	665,520	--	--	378,041	208,597	37,134	27,034	13,793	921
White pine	202,787	--	--	37,815	39,424	39,919	38,922	34,910	11,797
Spruce	174,561	--	--	91,703	67,002	15,856	--	--	--
Other softwoods	7,276	--	--	3,302	2,978	--	--	--	996
Hardwoods	86,832	--	--	--	34,979	36,557	2,794	5,252	7,250
All species	1,341,194	--	--	639,604	410,710	142,851	73,110	53,955	20,964

[1]International 1/4-inch rule.

Table 12.--Net volume of growing stock and sawtimber on timberland plantations by forest type and stand-age class, Wisconsin, 1983

Forest type	All classes	Stand age class (years)						
		1-10	11-20	21-30	31-40	41-50	51-60	61+
				Growing stock				
				Thousand cubic feet				
Jack pine	113,376	71	6,270	8,508	30,290	30,162	29,708	8,367
Red pine	465,200	2,985	49,106	173,040	136,516	95,517	5,849	2,187
White pine	66,662	397	9,996	9,468	5,031	26,627	6,774	8,369
Spruce	69,040	306	3,840	543	40,575	7,836	15,940	--
All types	714,278	3,759	69,212	191,559	212,412	160,142	58,271	18,923
				Sawtimber				
				Thousand board feet[1]				
Jack pine	225,986	--	5,654	2,496	31,296	73,992	80,891	31,657
Red pine	758,220	9,829	34,696	93,028	263,675	328,134	18,178	10,680
White pine	175,291	--	6,837	26,979	10,063	79,964	23,121	28,327
Spruce	181,697	--	5,283	--	115,669	20,709	40,036	--
All types	1,341,194	9,829	52,470	122,503	420,703	502,799	162,226	70,664

[1]International 1/4-inch rule.

Table 13.--Net volume of growing stock and sawtimber on timberland plantations by forest type and basal area class, Wisconsin, 1983

Forest type	All classes	Basal area class (square feet per acre)				
		<40	41-80	81-100	101-140	141+
			Growing stock			
			Thousand cubic feet			
Jack pine	113,376	753	22,977	40,702	39,001	9,943
Red pine	465,200	4,929	27,043	45,261	173,745	214,222
White pine	66,662	--	5,780	7,406	31,627	21,849
Spruce	69,040	306	5,632	4,431	--	58,671
All types	714,278	5,988	61,432	97,800	244,373	304,685
			Sawtimber			
			Thousand board feet[1]			
Jack pine	225,986	619	30,450	84,826	103,812	6,279
Red pine	758,220	17,220	45,511	80,252	374,945	240,292
White pine	175,291	--	10,680	17,204	100,877	46,530
Spruce	181,697	--	14,167	2,889	--	164,641
All types	1,341,194	17,839	100,808	185,171	579,634	457,742

[1]International 1/4-inch rule.

Table 14.--Net volume of growing stock and sawtimber on timberland plantations by ownership class and species group, Wisconsin, 1983

Ownership class	All species	Species group: Pine	Other softwoods	Soft hardwoods	Hard hardwoods
		Growing stock			
		Thousand cubic feet			
National forest	192,049	116,901	55,263	17,796	2,089
Misc. federal	15,339	15,094	--	--	245
State	32,387	30,262	388	96	1,641
County and municipal	111,176	103,631	--	5,508	2,037
Indian	5,202	5,202	--	--	--
Forest industry	44,101	41,790	808	1,027	476
Farmer	105,004	95,346	1,344	4,609	3,705
Misc. private corporation	34,527	29,037	--	4,894	596
Misc. private individual	174,493	155,071	8,838	5,473	5,111
All owners	714,278	592,334	66,641	39,403	15,900
		Sawtimber			
		Thousand board feet[1]			
National forest	601,896	413,149	165,208	17,462	6,077
Misc. federal	55,677	54,540	--	--	1,137
State	61,055	59,275	--	--	1,780
County and municipal	121,653	114,934	--	2,774	3,945
Indian	17,403	17,403	--	--	–
Forest industry	56,886	51,410	1,902	1,352	2,222
Farmer	194,483	180,616	1,530	5,537	6,800
Misc. private corporation	50,573	31,383	--	16,669	2,521
Misc. private individual	181,568	152,053	10,959	7,954	10,602
All owners	1,341,194	1,074,763	179,599	51,748	35,084

[1]International 1/4-inch rule.

Table 15.--Net annual growth of growing stock and sawtimber on timberland plantations by species group and forest type, Wisconsin, 1982

Species group	All types	Forest type			
		Jack pine	Red pine	White pine	Spruce
		Growing stock			
		Thousand cubic feet			
Jack pine	4,954	4,302	556	96	--
Red pine	32,549	1,172	30,643	707	27
White pine	2,691	118	775	1,798	--
Spruce	2,572	--	117	--	2,455
Other softwoods	252	8	197	37	10
Hardwoods	2,851	234	708	1,217	692
All species	45,869	5,834	32,996	3,855	3,184
		Sawtimber			
		Thousand board feet[1]			
Jack pine	16,295	15,076	994	225	--
Red pine	72,518	986	69,975	1,557	--
White pine	8,575	487	2,527	5,561	--
Spruce	11,986	--	367	--	11,619
Other softwoods	680	85	442	99	54
Hardwoods	6,493	244	3,501	1,647	1,101
All species	116,547	16,878	77,806	9,089	12,774

[1]International 1/4-inch rule.

Table 16.--Net annual mortality of growing stock and sawtimber on timberland plantations by species group and cause of mortality, Wisconsin, 1983

Species group	All causes	Cause of mortality					
		Insects	Disease	Fire	Weather	Suppression	Unknown and other
Growing stock							
	Thousand cubic feet						
Jack pine	808	7	49	29	15	10	698
Red pine	28	--	--	10	--	--	18
White pine	72	23	5	--	--	--	44
Spruce	236	--	3	--	2	105	126
Other softwoods	6	--	--	--	--	--	6
Hardwoods	806	--	139	16	34	1	616
All species	1,956	30	196	55	51	116	1,508
Sawtimber							
	Thousand board feet[1]						
Jack pine	494	4	65	--	6	--	419
Red pine	4	--	--	--	--	--	4
White pine	234	52	4	--	--	--	178
Spruce	54	--	3	--	9	--	42
Other softwoods	--	--	--	--	--	--	--
Hardwoods	519	--	123	--	73	--	323
All species	1,305	56	195	--	88	--	966

[1]International 1/4-inch rule.

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